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Photoluminescence, Raman and EPR spectroscopy studies of CVD diamond films

K.Fabisiak[+,*], *A.Banaszak*[*], *W.Bala*[**], *M.Kaczamarski*[***]

[+]Department of Physics, University of Bydgoszcz,
11 Weyssenhoffa Sq., 85-072 Bydgoszcz, Poland
[*]Department of Biophysics, Academy of Medicine,
13 Jagielonska St., 85-067 Bydgoszcz, Poland
[**]Institute of Physics, N.Copernicus University,
[5]Grudziadzka St., 87-100 Poland
[***]Institute of Physics, A.Mickiewicz University,
85 Umultowska, Poznan, Poland

Photoluminescence spectra measured at different temperatures, Raman spectra and EPR measurements are applied systematically to the study of defects in hot filament chemical vapour deposition (HF CVD) diamond layers grown onto (100) Si substrates. A series of photoluminescence lines at 2.674, 2.708, 2.741 and 2.82 eV are connected with radiative transitions from different excited states to the same ground state of a divacancy-related center.

Спектры фотолюминесценции, снятые при разных температурах, спектры комбинационного рассеяния и измерения ЭПР использованы для систематического исследования дефектов в алмазных слоях, выращенных методом химического осаждения из паровой фазы с применением накаленной нити (HF CVD) на подложках из кремния (100). Серия линий фотолюминесценции с максимумами при 2.674, 2.708, 2.741 и 2.82 эВ отнесена к излучательным переходам из различных возбужденных состояний на один и тот же основной уровень центра, связанного с двойной вакансией.

Diamond is of high importance for future applications in electronics and optics due to its unique properties. Its low absorption within a wide spectral range and luminescence in the blue region of visible optical spectrum are of interest for optoelectronic applications [1]. The ability to synthesize diamond films using CVD techniques has enhanced the prospects of diamond applications. However, defects induced during CVD diamond growth process may be a limiting factor for some applications as for example in electronics.

Although the quality of diamond films synthesized by CVD technique is continuously improved, most questions concerning the nature of defects and impurities incorporated into CVD diamond layer during its crystallization remain still unanswered [2]. Recent works on the photoluminescence (PL) of diamond layers show a strong dependence of PL spectra on growth methods and deposition parameters [3].

Luminescence measurements on diamond films grown by the Hot Filament Chemical Vapor Deposition (HF CVD) method show a number of defect centers which are unique for this material, because of the specific features of the synthesis technique. The best known examples are the neutral vacancy (GR1) and the vacancy trapped at dinitrogen (H3) and trinitrogen (N3) centers [4–7].

The diamond films studied in this work were deposited onto (001) silicon surface in a Hot Filament CVD reactor at the pressure of 60 mbar. The flow rate of hydrogen gas was 80 sccm (standard cubic centimeter per minute) and that of acetylene was 10 sccm. During the growth, the substrate temperature was kept at 800°C. The silicon surface